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SCREEN FOR SAND CONTROL IN A WELLBORE

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SCREEN FOR SAND CONTROL IN A WELLBORE

Cross-Reference to Related Applications

[0001] This application claims benefit of United States provisional patent application serial number 60/495,480, filed August 15, 2003, which is herein incorporated by reference.

Field of the Invention

[0002] Embodiments of the present invention generally relate to wellbore completions, and more particularly, to a screen design for sand control.

Description of the Related Art

[0003] Hydrocarbon wells are typically formed with a central wellbore that is supported by steel casing. The casing lines the borehole in the earth, and the annular area created between the casing and the borehole is filled with cement to further support and form the wellbore. While some wells are produced by simply perforating the casing of the central wellbore and collecting the hydrocarbons, wells routinely include portions left open or unlined with casing. Because they are left open, hydrocarbons in an adjacent formation migrate into these wellbores where they are affected along a perforated tubular or sand screen having apertures in its wall and some kind of filtering material to prevent sand and other particles from entering. The sand screen is attached to production tubing at an upper end and the hydrocarbons travel to the surface of the well via the tubing.

[0004] Since open wellbores lack support along their walls and the formations have a tendency to produce sand and particulate matter in quantities that hamper production along a sand screen, open wellbores are often treated by fracturing and packing. Fracturing a wellbore or formation means subjecting the walls of the wellbore and the formation to high pressure solids and/or fluids that are intended to penetrate the formation and stimulate its production by increasing and enlarging the fluid paths towards the wellbore. Packing a wellbore refers to a slurry of sand that is injected into an annular area between the sand screen and the walls of the wellbore

to provide a gravel pack that supports the wellbore and provides additional filtering to the hydrocarbons. Apertures through the sand screen are sized to retain the gravel pack.

[0005] Since the sand screen's function includes filtering of particles, these particles can build up over time with smaller particles forming bridges at the sand screen that at least partially plug the sand screen. After producing through the sand screen for some time, the sand screen becomes plugged and prevents or slows the flow of fluids for production. This can occur regardless of whether the wellbore includes a gravel pack. A backflow of fluid by reverse pressurization supplied through the production tubing reopens the plugged sand screen in order to reestablish flow through the sand screen. Often, the fluid used in the backflow includes an acid that aids in dissolving and dislodging debris trapped by the sand screen. The backflow operation requires applying reverse pressures that can be approximately three thousand pounds per square inch.

[0006] During some wellbore completion or remediation procedures, it is necessary to stop the flow of production with a fluid loss mechanism. These mechanisms can include mechanical flappers; however, mechanical flappers often stick open or shut requiring costly and time consuming efforts to correct. Alternatively, a solution containing particles in liquid can provide a chemical seal that applies to the sand screen to plug the apertures through the sand screen. Application of a second solution at a predetermined time removes the chemical seal from the sand screen. If normal procedures for releasing the chemical seal from the sand screen fail, a reverse pressurization must be applied across the sand screen in order to stimulate the chemical seal such that the plugged sand screen reopens.

[0007] Originally, sand screens simply consisted of slotted tubing; however, this provides little control as to the size of particles actually screened. A second type of sand screen includes a perforated tubing with a wire wrapped screen positioned on its outside that is formed by wrapping wire around longitudinal rods such that the spacing between the wraps of wire is selected to be sufficiently small to filter

particles. A variation on the wire wrapped screen includes providing a packing of sized particles between two wire wrapped screens. This packed screen increases pressure across the sand screen which decreases velocity in order to slow production as required in various completions. However, this packed screen is heavy, and it is difficult to provide and insure an even distribution of the sized particles therein. Another type of more recent and improved sand screen includes premium screens consisting of layers of metal fiber or metal powder between sheets of woven mesh that wrap around a perforated tubing. Therefore, the premium screens require a longitudinal weld in order to secure and seal the sheets of material that wrap around the perforated tubing. Thick premium screens become brittle at the longitudinal weld due to the heat affected zone at welds of the premium screen. Especially suited for thin premium screens, weak resistance welds provide one option for longitudinally welding. A shroud having apertures in its wall may be necessary to protect the premium screens.

[0008] Current sand screens lack the ability to withstand the reverse pressurization procedures. Under normal pressure conditions, the perforated tubing provides support for the premium screen since forces acting on the premium screen urge the premium screen against the outside surface of the perforated tubing. However, the reverse pressure urges the premium screen outward and places hoop stresses on the premium screen thereby causing the premium screen to fail at the longitudinal weld that holds it wrapped around the production tubing. Additionally, reverse pressurization using acid in excessive concentration dissolves a phenolic resin coating on the sized particles within packed screens. Thus, acid reverse pressurization can further plug the screen with the dissolved phenolic resin, damage other production tools and equipment with the dissolved phenolic resin, or destroy the functionality of the packed screen itself.

[0009] There exists a need for an improved sand screen for use in a wellbore that is seamless and adaptable for different particle size filtration and production tubing diameter.

SUMMARY OF THE INVENTION

[0010] The present invention generally relates to a sand screen for use in a well that employs a seamless tube shaped filter member covering perforations in a length of perforated tubular. The filter member includes a monofilament or multifilament wire that is precisely wound to control angle and spacing of the wire. Configuration of a wind pattern and the amount of wire wound controls aperture size for filtering particles, flow characteristics through the filter member, and overall strength of the filter member. Seals at each end of the filter member can secure and circumferentially seal the filter member on the perforated tubular.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] So that the manner in which the above recited features of the present invention can be understood in detail, a more particular description of the invention, briefly summarized above, may be had by reference to embodiments, some of which are illustrated in the appended drawings. It is to be noted, however, that the appended drawings illustrate only typical embodiments of this invention and are therefore not to be considered limiting of its scope, for the invention may admit to other equally effective embodiments.

[0012] Figure 1 is a sectional view of a sand screen positioned in a wellbore.

[0013] Figure 2 is a view of a filter member of the sand screen according to one embodiment of the invention.

[0014] Figure 3 is a view of the filter member with a first wrap of a wire around a mandrel.

[0015] Figure 4 is a cross sectional view of the sand screen illustrating a non-offset overlapping wind pattern.

[0016] Figure 5 is a cross sectional view of the sand screen illustrating an offset overlapping wind pattern.

[0017] Figure 6 is a sectional view of the sand screen with sealing rings adjacent ends of the filter member.

[0018] Figure 7 is a cross sectional view of the sand screen having a filter membrane therein.

[0019] Figure 8 is a cross sectional view of the sand screen having a packing therein.

DETAILED DESCRIPTION

[0020] Figure 1 illustrates an embodiment of the present invention in use within a wellbore 100. The wellbore 100 includes an open borehole 102, a production tubing string 104, and a sand screen 106 within the production tubing string 104. The sand screen 106 includes a filter member 108 surrounding a perforated tubular 110 that has apertures 112 in its wall. Seals 114 circumferentially seal the ends of the filter member 108 to the perforated tubular 110 of the sand screen 106. The sand screen 106 is shown positioned in the wellbore 100 adjacent a producing formation. While not illustrated in Figure 1, the wellbore 100 may further include a gravel pack between the open borehole 102 and the sand screen 106. The open borehole 102 may be any orientation within the wellbore 100 such as when the open borehole 102 forms a lateral wellbore. For extended lengths, the sand screen 106 can be joined to any number of additional sand screens through conventional tubular make-up at the ends of the perforated tubular 110.

[0021] Figure 2 shows the filter member 108 of the sand screen 106. The filter member 108 is a seamless tube of a single monofilament wire 200 that is substantially flat and precisely wound to control angle and spacing of the wire 200. The wire 200 can have a cross section of any shape such as ribbon, round, wedge, or house-shaped and can be a single monofilament wire, a single multifilament wire, or more than one monofilament or multifilament wire. If needed, two lengths of wire may be fusion welded together to provide the wire 200 for the filter member 108. The wire 200 can be any material capable of being drawn. Preferably, the filter

member 108 is wound from wire 200 of a metal such as any 300 derivative stainless steel, titanium, or an alloy such as Alloy 20. Depending on the amount of wire 200 wound, the wall thickness of the filter member 108 can vary from .06 inches up to approximately an inch in thickness. While the length of the filter member 108 can be any length, it is preferably at least four feet, and most preferably eight feet. The wire 200 is wound to provide an appropriate inside diameter corresponding to a perforated tubular of any given outside diameter. Sintering the filter member 108 fixes the wire 200 in place by diffusion bonding all the wire contact points. Thus, sintering ensures that the aperture geometry provided by the wound wire stays static and increases strength levels of the filter member 108. However, the filter member 108 can be used without sintering.

[0022] Figure 3 illustrates a first wrap of the wire 200 across the length of a mandrel 400 as the filter member 108 forms by winding the wire 200 on the mandrel 400. In manufacturing the filter member 108, the mandrel 400 is positioned on a lathe (not shown) and rotated as the wire 200 is fed onto the mandrel 400. As the wire 200 is wound around the mandrel 400, the location of the mandrel 400 relative to the wire is transposed back and forth by moving the mandrel 400, moving the wire 200 being fed, or moving both the mandrel 400 and the wire 200 being fed. The mandrel 400 includes two end rings 402 separated by longitudinal members 404. By not removing the mandrel 400 from the wound wire 200, this type of mandrel 400 can form an integral part of the filter member 108. Thus, the filter member 108 including the mandrel 400 positions around the perforated tubular 110 (shown in Figure 1). Sintering of the filter member 108 occurs on the mandrel 400. Additionally, the end rings 402 of the mandrel 400 provide a solid and uniform surface for coupling the filter member 108 to the perforated tubular 110 with the seals 114.

[0023] In one embodiment, the mandrel 400 is a perforated tubular that the wire 200 winds around to form the filter member 108. As such, the wire 200 can wind directly around the perforated tubular 110 shown in Figure 1. Alternatively, the mandrel 400 can be any tubular member removable from the wound wire 200 to

provide the filter member 108 as shown in Figure 2. For example, the mandrel 400 and filter member 108 can be made of different materials such that when heated an outside diameter of the mandrel 400 is smaller than an inside diameter of the filter member 108, thereby permitting removal of the mandrel 400. Other arrangements that allow selective reduction in the outside diameter of the mandrel 400 can provide the mandrel 400 that is removable.

[0024] The filter member 108 may be wound to produce a tortuous path for fine filtration, a straight path for increased permeability, or anywhere in between. The tortuous path slows velocity flow and increases pressure to prevent formation erosion which is particularly useful in high production rate wells. In order to provide the straight path, the wire 200 winds such that overlapping portions are non-offset as schematically shown in Figure 4. The tortuous path utilizes offset overlapping winding of the wire 200 as schematically illustrated by Figure 5. The non-offset pattern has higher permeability than the offset pattern.

[0025] Figure 6 illustrates two possible embodiments for the seals 114 shown in Figure 1. The seals 114 can be any known device that secures and circumferentially seals the filter member 108 to the perforated tubular 110 such as a shrink fit ring that shrinks onto the perforated tubular 110 when heated, a threaded ring, a pin, a braze, a glue, a sweated ring or a weld. Additionally, the seals 114 may not be required at all if the filter member 108 is wound directly to the perforated tubular 110. Referring to Figure 6, a first end ring 300 includes a tapered surface for wedging between the filter member 108 and the perforated tubular 110 thereby securing and circumferentially sealing. A set screw 306 secures the first end ring 300 to the perforated tubular 110. A second end ring 301 secures to the perforated tubular 110 with weld 304 and includes a tapered surface wedged between another filter member 108 and the perforated tubular 110 in order to secure and circumferentially seal. Both end rings 300, 301 have a ring of an elastomeric material 302 or thermoplastic layer that ensures sealing between the filter member 108 and the perforated tubular 110.

[0026] As shown in Figure 7, an alternative embodiment of the sand screen 106 has a filter member 108 that includes a filter membrane 804 such as a premium screen within the wall of the filter member 108. As such, winding of the wire is stopped at a predetermined wall thickness 800 of the filter member so that the premium screen can be wrapped around the filter member 108 prior to completing the winding of the wire and forming an outer wall portion 802. The premium screen 804 provides the filtering or supplemental filtering while the wound wire 800, 802 provides strength and protection for the premium screen 804. As shown in Figure 8, a filter member 108 of the sand screen 106 may include a packing 904 of sized particles in an annular area defined by an outside of an inner coil 900 and an inside of an outer coil 902 of wound wire as described above. Either of the inner or outer coils of wound wire may be replaced with a slotted tubular, a wire wrapped screen, a premium screen or a wire mesh. A seal such as a weld at each end of the inner and outer coils retains the sized particles in the annular area.

[0027] Assembling the sand screen 106 includes winding a wire 200 into a substantially seamless tubular shape of the desired configuration, length, diameter, and thickness in order to provide a filter member 108. Sintering the filter member 108 diffusion bonds the wire contact points. Positioning the filter member 108 around an outer wall of a perforated tubular 110 covers at least some apertures 112 through the perforated tubular 110 with the filter member. Providing seals 114 at each end of the filter member circumferentially seals the filter member 108 at its end to the perforated tubular 110 to provide the sand screen 106.

[0028] Since the filter member 108 lacks weld joints, the filter member provides a uniform and effective filtration surface about its entire circumference. Additionally, the hoop strength of the filter member 108 is uniform in order to effectively distribute any hoop stresses applied to the filter member. The wall thickness of the filter member 108 can be increased to provide further strength to the filter member.

[0029] While the foregoing is directed to embodiments of the present invention, other and further embodiments of the invention may be devised without departing

from the basic scope thereof, and the scope thereof is determined by the claims that follow.